THE TECH

SPECIAL MINING AND GEOLOGY ISSUE

VOL. XXIX. NO. 85. BOSTON, MASS., SATURDAY, JANUARY 15, 1910 PRICE FIVE CENTS

Students and Instructors

of the Mining Course

THE MINING COURSE

By PROF. CHARLES E. LOCKE.

The present Course III has three options. Option 1 is the general option which is designed for all men except those who have definitely planned that their future work shall be along metallurgical or geological lines. Option 2 is for men who plan to follow metallurgy and who, therefore, require more of the mechanical engineering which is useful around large plants. Option 3 is designed for men who desire positions on the U. S. Geological Survey or who have a similar geological position in view. Options 1 and 3 are identical up to the end of the third year. The differentiation in Option 2 begins in the second year.

Formerly several other options were offered, but these were given up as inexpedient because it was found that a man who had specialized in one direction was very liable to secure a position at graduation for which his special training was entirely unsuited.

As arranged at present the first two years are largely spent on fundamental subjects. The first year has mathematics, chemistry, drawing, language and English. The second year has chemistry, physics, mathematics, surveying and English. A start is made in geology and a short course in Elements of Mining Engineering introduces the men to the professional work of the course.

In the third year the work becomes more specialized. The professional work includes mining engineering and assaying. Geology and analytic chemistry are continued and courses are given in mineralogy and petrology. The balance of the time is devoted to applied mechanics, physics (heat), political economy and general studies.

The fourth year work is largely professional and includes lectures in ore dressing, metallurgy and metallography, work in the metallurgical laboratory and heat measurements, lectures and laboratory work in electricity, lectures in hydraulics, work in forgeing, lectures and field work in geology, and courses in memoirs, sanitary science, theoretical

(Continued on page 30.)

GEOLOGICAL RESEARCH

By PROF. R. A. DALY.

Dynamical geology represents the application of physics and chemistry to the problems of the earth's evolution. It is, therefore, highly appropriate that geological research should be and is, among our instructors and graduate students, an integral part of the Institute's work. Every year the principles of chemistry and physics are being enlarged or restated. Either of these sciences is in a state of flux. A great number of geological problems are being attacked with the new methods provided by physical chemistry. So rapid is the advance in all three of the basal sciences that revision of the principles of physical geology is a constant necessity. The geologist has an obvious advantage who has among his colleagues physicists and chemists, who will draw his attention to recent discoveries, or to improved statement of fundamental principles, and who will advise him where only the expert is a safe guide. Such is the opportunity of a geologist at a well equipped technical institution, or at an equally well equipped university. Research on the principles of physical geology is there more fittingly prosecuted than even in the government surveys.

Every advance made in general or dynamical geology is a direct or indirect gain to economic geology and, therefore, to the thoroughly trained, practical mining expert. A successful mining geologist has the research spirit. Routine and slavish adherence to text book, handbook, or lecture instruction are not for him. As millions of dollars may be interested in his report, he must go deeper into interpretation of local facts than anyone has ever done before. No two mining camps are alike, no two problems in finding or following an ore-body are alike; each case requires a new and special application of geological principles, and these are tested with each application. A large part of the enormous financial waste in present-day mining could be saved if managers and "experts" were trained in the atmosphere and methods of geological in-

(Continued on page 30.)

ORE DRESSING

By PROF. R. H. RICHARDS.

The beneficiating of minerals, by which is meant the making of mineral substances most serviceable to men, is divided into three parts: (1) Mining takes the ore from the ground in the crude state; (2) Ore-Dressing separates the quartz or other waste materials from the valuable minerals by mechanical means; and (3) Metallurgy, which separates by chemical means, using fire or water, the remaining waste substances from the valuable metals, turning out the latter in condition for practical use.

Ore-Dressing uses the various breakers and crushers to sever the valuable minerals from the waste, and then the screens and classifiers, followed by the jigs, tables and vanners, to separate the good from the bad. While the above machines use water and specific gravity for separating the minerals, there are a number of other processes which help by separating the minerals which are of the same specific gravity and therefore cannot be separated by the above method; these are the magnet, which separates the magnetic minerals from the non-magnetic minerals; the static electrical machine, which separates the mineral conductors of electricity from the non-conductors; and the flotation methods, which separate the minerals that are held up by the surface tension of water from those minerals that are not.

The teaching of Ore-Dressing at the Institute is done by lectures illustrated by laboratory work, which is timed to come as nearly with the topics of the lectures as possible.

Ore-Dressing Laboratory.

The laboratory work is laid out for giving the students as much practical knowledge of ore-dressing as possible in the time allowed, and to furnish the tools and materials and guidance for investigation. The chief features of the work are: (1) A concentration of a lead ore. (2) A run on a gold ore in a California quartz mill. Each of these illustrates the method of grouping a set of machines together for the purpose of

(Continued on page 25.)

COURSE IN GEOLOGY

By PROF. T. A. JAGGAR, JR.

The Institute provides courses in what is known as "Option 3 in Mining," and Course XII, "Geology and Geodesy," designed to train men for professional life in geology and topography. Students planning to become geologists ought to take the mining engineering course, so as to get a solid foundation of work in chemistry, physics, mathematics, and engineering. subjects essential for a geologist's training. Few students at this institution train themselves to become topographers. This is unfortunate, as the science of making artistic and accurate maps ought to rank as high as any branch of learning in the humane professions. It is to the wonderful work of such men as F. Matthes, M. I. T., 1895, United States Geological Survey, topographer of the Grand Canons of the Colorado and the Yosemite, that we owe a debt of gratitude for bringing topographical science up to a standard comparable with the finest geological or astronomical work. Good maps are essential to the study of all engineering, hydrographic and geological problems, and the making of them deserves much more attention than is now given to it in the average engineering course. The work calls for a high artistic sense, like that of the architect, and also for endurance, administrative ability in the field, thorough knowledge of astronomy and geodesy, and a keen appreciation of the relations between geological structure and topographic form. I think that there is a field of growing importance for the man who will train himself to be an expert togoprapher. The large reclamation, mining, and power projects which are now engaging the attention of the world, as well as such novelties as automobiling and aviation, are bringing the forms of the land closer to mankind. In everyday life, men engaged in commerce, real estate, and transportation, feel the need and the lack of good maps. There is a bill now before the Massachusetts Legislature to provide for the preparation of a State geological and economic atlas, and an important part of the work provided for under this bill is the revision of all the topographic

(Continued on page 26.)

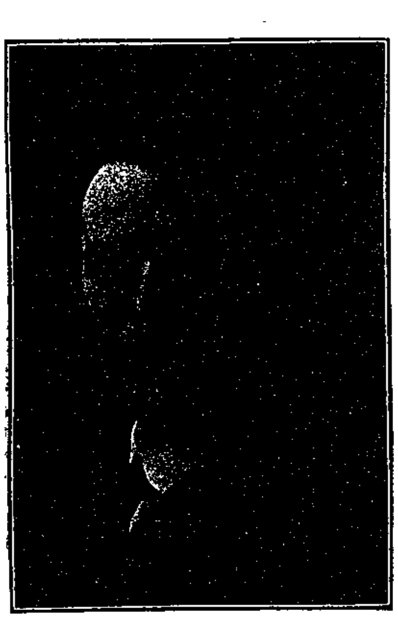
MINERALOGY; PETROLOGY

By PROF. C. H. WARREN.

No man can fairly consider himself a broadly educated one who is not to some extent familiar with the structural character and history of the earth's crust, upon which he lives and from which comes in the end so large a portion of the material things of everyday life. The visible units of the earth's crust are the definite chemical compounds known as minerals, or perhaps in a larger sense, the various individual mineral aggregates, the rocks. A somewhat general knowledge of these units, such, for example, as may be obtained in a course in general geology, is usually sufficient for most men, and the same is true regarding the earth's structure and history. Certain groups of professional men, however, more particularly mining engineers, chemists, and chemical engineers, have occasion to deal more or less constantly with minerals or rocks, or both, as physical and chemical objects, and to such, a more thorough knowledge of these objects and of the methods of studying them is important.

The general object of the course in mineralogy and petrology at the Institute is to supply the needs of these groups of students. In mineralogy the specific aims are, to furnish the student with an opportunity to become familiar with the more important mineral species, their uses and relative importance, and to some extent, their modes of occurrence, to obtain a general view of the range of chemical composition among minerals, and particularly to become skilled in the practical methods of studying them.

In a general way the actual work of the course consists, first, of a preliminary laboratory study, accompanied by some lecture work, of the important minerals and of methods of examining and determining them, and secondly of a large amount of practice in such work. The preliminary work naturally includes a small amount of crystallography. The



PROF. C. H. WARREN.

crystalline state is the normal one, under ordinary conditions, for most solid matter, whether made in the laboratory or occurring naturally, and a correct appreciation of the leading characteristics of crystalline matter is important and can be used easily and to great advantage in studying substances in general.

The methods used in the examination and determination of minerals aim toward making the greatest possible use of such physical properties, cleavage and hardness for example, as can be successfully studied without elaborate apparatus and the combining of the facts thus obtained with the information gained from simple tests made with the aid of the blowpipe or by short and easily performed qualitative, chemical reactions made in the wet way. This combination of physical and chemical properties renders identification vastly quicker and generally more certain than reliance on either one alone.

For use in the preliminary work several large and carefully selected reference and study collections are available for study, while in the later determintive wo rk an extensive collection of "Unknowns" accumulated from mineral deposits the world over is used.

PROF. E. E. BUGBEE.

Petrology, which is, broadly speaking, the science of rocks, is covered by two courses. The first of these is designed to present the principles upon which the science is based and to furnish the opportunity to become familiar with the leading rock types, their distribution and modes of occurrence, and with practical methods of identifying such of these rocks as can be successfully identified in the field or mine. The work is therefore essentially a laboratory course accompanied by lectures or recitations and assigned reading. While the use of the polarizing microscope for the study of thin rock sections is not a part of this course, its great value as a means of study is shown and microscopic sections are used to illustrate principles and features not readily apparent or not apparent at all without their use. The petrology is required of all mining engineering students and is open to others who can and desire to take it.

The second course is a more advanced one, known as petrography, to which the first is a necessary preparation. This is naturally a course for those who wish to become more proficient in the application of geology to mining or those who intend to follow geology as a profession.

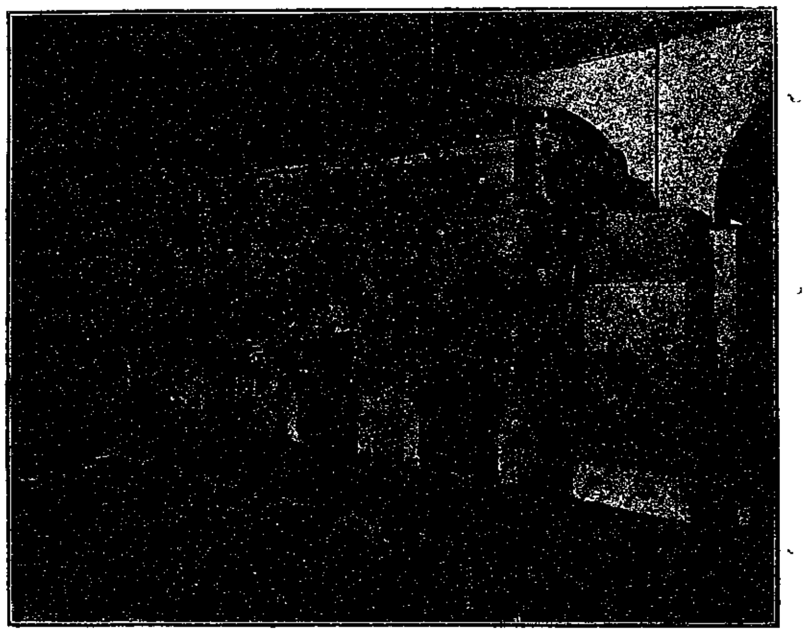
Petrography is the systematic study and classification of rocks and involves to a very considerable extent the use of the polarizing microscope. A large part of the work of this course consists, therefore, of learning methods of microscopic study and of putting them into practice. For identifying the constituent minerals of a rock with the microscope, finely crushed material may be studied, or very thin rock-slices. The latter are more commonly used, since they have the great advantage of having all of the mineral grains of the same thickness, and therefore comparable for certain optical properties which vary with thickness. They also show exactly what the actual relationship of one mineral to another is. These sections are made by simply grinding down a small slice of rock until it has a uniform thickness of about 0.03 mm. The area is usually from 1.5 to 2.0 sq. cm. The section is mounted on a glass slide with Canada balsam, and is covered with a cover-glass. Although one can learn to grind these sections one's self with a little practice, they are usually prepared by men who make it their business to cut sections. The cost is but a trifle (30 to 40 cents). These sections are quite transparent and permit not only the structure of the rock to be clearly seen under the microscope, but also make it possible to identify the individual mineral constituents by means of their optical properties.

These are just as characteristic for each species as are their chemical reactions or macroscopic characters and can be determined with great precision even on exceedingly minute grains. The determination by this means must not be thought to be always easy, for the exercise of much patience, skill and thought are often necessary for the making of a single determination. Practice, however, makes the recognition of the more common minerals a comparatively easy matter. ..e identification o. a rock by means of a thin-section can be done quickly and easily in most cases. In petrographic work, where the chemical as well as the mineral composition is desired, this may often be computed approximately from measurements made microscopically upon the individual minerals if their composition is known, although for very accurate work, chemical analyses must be resorted to.

The polarizing miscroscope is also a valuable tool to the chemist in his study of laboratory salts, to the metallurgist, and sometimes to the mill manager.

Besides large collections of rock specimens, the Institute also has hundreds of thin-sections available for study, and these collections are being constantly added to. There are twelve microscopes for regular petrographic work, also a large microscope fitted with many useful accessories particularly adapted for research work.

Aside from the direct and obvious value of mineralogic and petrologic knowledge to the chemist or chemical engineer, the mining engineer, and geologist, the work in these subjects has an indirect value which, although not always recognized, is to the writer's mind quite if not really more important than the mere knowledge they impart, and this is the training of the powers of observation and deduction which must be exercised constantly throughout such work if any measure of success is to be attained.



MUFFLE FURNACES.

FIRE ASSAYING

By PROF. EDWARD E. BUGBEE.

Fire assaying is a particular branch of analytical chemistry by which the quantity of metals in ores, furnace products, bullion, etc., is determined by the aid of heat and dry reagents. The object in each case being to separate the metal sought from the other components of the ore, weighing it in the metallic state. The determinations most commonly made are of gold, silver and lead, with occasionally tin, mercury and platinum. Assaying is principally confined to mining and metallurgical operations where it is desired to obtain accurate results in the shortest possible time. Fire assaying is not only by far the most rapid method for the determination of gold and silver in ores, but with proper precautions it is also the most accurate method for these determinations. The fire assay for lead is not as accurate as some of the wet methods, but on many ores it is quite satisfactory, and as the fire determination may be done with the expenditure of perhaps one-tenth the time and labor required for the wet method, it is in general use where speed is more important than extreme accuracy.

The course in fire assaying as given at the Institute is designed not merely to give a theoretical and practical knowledge of the subject itself, but also to serve as an introduction to the study of metallurgy which follows it. The aim of the department is to teach the student the reasons for the various steps taken, as well as the limitations of the processes. Fire assaying is just emerging from the "rule of thumb" stage and the student of today should benefit thereby. In addition to the third-year course in assaying further practice is obtained in the fourth year course, termed metallurgical laboratory, required of all Course III students. Here the men make various metallurgical tests, each step of which is followed by assays and the student is shown how to check his work as the surveyor checks himself by closing a survey.

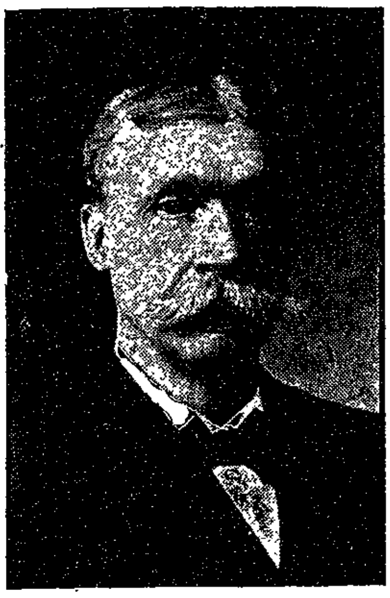
Assaying is to the mining engineering course what surveying is to the civil engineering course. It is a fundamental subject so far as the course is concerned and one to which practically every mining engineering graduate at one time or another in his career will have occasion to refer. For many men it will be the opening through which they enter the profession, others will use it from time to time as emergency may require, while still others will employ their theoretical knowledge to insure the engagement of competent men to do the work for them.

Attention is called to the Geological Survey Examination to be held on Feb. 16th and 17th. See Prof. Jaggar's article for particulars.

THESIS

By PROF. R. H. RICHARDS.

The thesis is regarded in the mining department as the most important part of the course; in fact, the crowning feature. An investigation calling for an intelligent plan, exact observations, reliable records, intelligent discussion, and wise conclusions calls out into practice all the training the student has received at the school, together with his outside experience. It helps him to fit himself for graduation, and his teachers to decide if he is fitted. Among the many lines for thesis that can be



PROF. R. H. RICHARDS.

chosen, the following are perhaps the most obvious: Ore-dressing test to ascertain the best method of concentrating an ore. This at first glance looks like doing the same thing over and over, but when it is borne in mind that no two ores are alike and the greatest commercial economy will be obtained by crushing one ore to one size and another to another, and that they differ likewise as to the dividing line for re-crushing tailings and also middlings it will be seen there is a great deal to be done to settle these questions. Ore-dressing investigation to ascertain the settling velocity of different sizes of grains of minerals of different specific gravity: This is one line of investigation of great importance to the mill man and the designer of mills; it is only one of many lines that can be suggested. Metallurgical test: A blast furnace can be made on a copper ore, including the preliminary analyses of the ores and fluxes, the computation of the charge to yield the best result in copper recovered and least copper lost in the slag. During the run, heat measurements can be taken and the complete heat balance sheet prepared, showing where the heat was used to advantage and where it was lost, and how the run could be better done the next time. Metallurgical investigation: The student may take the investigation of the fusing point of lime iron silicates as used in lead smelting slags. He will have all the slags to prepare of pure known materials, the apparatus to put in order and calibrate, the tests to make, the conclusions to draw and the paper to write. This is only one of many that might be named. Assaying test: The student may be given an ore and try on it all the known methods of assaying such an ore, he can try all the possible variations in heats at the different periods in the process and all the different proportions in the fluxes to reach the best method of assaying that class of ore. Assaying investigations: The student may try the losses in silver in cupelling, using variable quantities of lead, variable heats and different makes of cupel, at the end he sums up the results and concludes the conditions that will give him the most reliable results. Geological survey: The student can make a geological survey, getting the location, dips, strikes, kinds of rock, and after mapping it all can draw sections and conclude with considerable certainty what he will find and where he will find it when he goes down below the surface. Geological investigation: The student can make a careful examination of a rock formation and take a great many samples

PALEONTOLOGY

By PROF. H. W. SHIMER.

The study of paleontology at the Institute is pursued along two lines. The one considers the identification of the earth's strata through the fossils included in them and the other the evolution of life upon the earth. At the Institute more emphasis is naturally laid upon the former, embodied in the courses in Index Fossils.

If any particular deposit of stratified rock be examined we shall find certain fossil forms peculiar to only that stratum and other strata which were in other regions deposited at the same time. This being demonstrated, we may certainly be able to identify that stratum thereafter by the fossils found in it, no matter in what locality found. The identity of formations in different sections of a country, or, as we usually say, their correlation, is of the utmost importance to both the geologist and the mining engineer. For example, in the lower peninsula of Michigan a stratum of limestone runs about 100 per cent. calcium carbonate and is hence much sought after for use in clarifying sugar and for making Portland cement. It is underlain and overlain by shale beds of similar lithologic characters, but carrying different fossils, and as the strata are almost horizontal, separate outcrops of the limeestone are few. Hence here, in areas of shale outcrops, quarries are located by an examination of the surface fossils which indicate whether the shale is that which underlies or overlies the desired limestone.

A knowledge of Index Fossils in each year becoming increasingly necessary for the geologist and the mining engineer more and more freqently do we find practical mining men coming back to take such work. The following is an extract from a letter of such a man from the southwestern United States: "I find that I cannot carry on my work to the best advantage without a knowledge of the fossils. I do

PROF. H. W. SHIMER.

not see how any man can do prospecting and development work in this region unless he knows something about fossils. Since I have been here, a graduate of a technical school came down to direct the sinking of a shaft for his company. He spent an immense amount of money and time in sinking that shaft in Devonian limestone. Now the ore only occurs in the Carboniferous of that region. He had crossed a fault which brought up the barren Devonian rock. If he had known the fossils, which were abundant, he could have told in five minutes that he was on the wrong track, and could have saved his company an immense amount of money."

In working out the structure of a country, noting faults or boring artesian wells, such knowledge is equally necessary. As an instance of its use in the latter work, the following may be quoted: "In two instances within the past year by the aid of these fossils (oysters) brought up from great depths in diamond drill cores, cities in Texas upon the point of abandoning the attempt to procure artesian water have been warranted in drilling a few feet farther where the desired artesian flow was procured."

Likewise is a knowledge of index fossils most desirable for work upon the geological surveys of Canada, the United States and Mexico, for each of which the Institute has trained men. A couple of years ago one of our men on the Mexican survey, was deploring that he had not taken more work in that line since so much of his work on the survey was along lines involving the knowledge of fossils.

The undergraduate work in Index Fossils at the Institute is confined to two courses: (1) The laboratory part of the stratigraphic geology, showing what a fossil is, how preserved, and, through constant comparison with recent forms of life, what the soft and hence unpreserved parts of the body were like, and how these built up the hard parts which are preserved in the fossil state. (2) The course in North American Index Fossils which, through the identification of two or three hundred very common fossils gives a good knowledge of classes and ages, ability to note minute differences, and the training to identify unknown fossils and thus the age of the rock enclosing them. In the advanced courses in paleontology, the knowledge and training thus gained are used in original work for publication upon some specific area, including identification of fossils, determination of the age of the rocks, etc.

(THESIS, continued.)

of the rock. He can then make slides of the rock and study its structure, microscopically and chemically, and make up his mind to what great group of rocks it belongs, having done so he can then argue from analogy what valuable deposits are liable to be found in its neighborhood, he can also contribute towards the settling of the geological age of the rock.

In every one of these supposed cases the student is living beforehand through one of the experiences which go to make up the life of the mining engineer, the metallurgist and the geologist.

SLIMES.

Course III is perhaps the most cosmopolitan given at the Institute. Besides men from twenty-one states in the Union, Central America sends one man, China three, Japan one, Mexico two, Nova Scotia one, British Columbia one, South Africa one, and West Indies one.

The following is an approximate classification of the undergraduates according to their options:

	Op. I	Op. II	Op. III	Totals
Seniors ...	13	2	14	29
Juniors ...	23	2	3	28

Option I is the general mining course, Option II is metallurgy, and Option III is mining geology.

In regard to the preparation a mining engineer should have for his work, the matter of reference books is important. Among the more essential ones are: Spurr's "Geology Applied to Mining"; Trumbull's "Underground Surveying," a book containing much valuable information in little space; the handbooks of Trautwine and Kent; "Estimation of Ore in a Mine," by T. A. Rickard; Richards' "Ore Dressing"; Hofmans' "Metallurgy of Lead" and Peters' "Metallurgy of Copper."

ORE-DRESSING.

(Continued from page 23.)

making a complete treatment, including the coarse crushing, the fine crushing, the preliminary and the finishing concentration. (3) The remaining laboratory equipment is to provide for the study of individual machines; for example, the magnet with high magnetic power for treating minerals with low magnetic susceptibility; the magnet with low power for minerals of high susceptibility; the various designs of classifiers, the Wilfley table, the Wilfley slimer, the steep end shake vanner, and such other machines and processes as may from time to time come forward for investigation.

There are three stages in the work: (1) The introductory object lessons; (2) the testing of ores for a process; and (3) the investigation of principles of ore-dressing to obtain constants or data for the guidance of mill men and investigators of the future. The second and third stages are used in the thesis work.

THE TECH

Published daily, except Sunday, during the college year by students at the Massachusetts Institute of Technology.

Entered as second-class matter, Sept. 29, 1909, at the post office at Boston, Mass., under the Act of Congress of March 3, 1879.

GENERAL MANAGER.
R. H. Ranger 1911.

NEWS BOARD.
D. P. Gaillard 1911 ......Editor-in-Chief
A. L. Fabens 1910 ....Institute Editor
J. I. Murray 1912 ....Athletic Editor
W. J. Orchard 1911 ....Society Editor
G. M. Keith 1912 ....Exchange Editor

BUSINESS BOARD.
N. DeForest 1911 ......Business Manager
D. N. Frazier 1911 ...Circulation Manager
H. Merrill 1912 .....Advertising Manager

SPECIAL ISSUE.
John D. MacKenzie 1911
H. F. Dolliver 1911 ....Assoc. Editor

ASSOCIATE NEWS BOARD.
S. C. Bates 1911 ....Chairman
L. Rosenstein 1910 ....Monday
M. A. Oettinger 1912 ....Tuesday
L. G. Fitzherbert 1911 ....Wednesday
D. J. McGrath 1912 ....Thursday
E. B. Moore 1912 ....Friday

ASSOCIATE BUSINESS BOARD.
A. W. Yeareance ....Notices
H. E. Kemp 1912 ....Posters

NEWS STAFF.
H. F. Dolliver 1911 P. M. Tyler 1912
E. W. Davis 1912 A. W. Kenney 1912
F. H. Busby 1912 T. E. Senior 1913

ADVERTISING STAFF.
H. W. Hall 1912 C. Fallon 1912

CIRCULATION STAFF.
R. H. Fox 1912 W. Guild 1913
H. P. Fessenden 1913

CARTOONS.
N. E. Brooks 1913 F. D. Rich 1913
W. J. Mooney 1913

Office 42 Trinity Place.
Telephone, Back Bay 2184.

All communications schould be addressed to the proper departments.

Subscriptions $1.50 per year in advance. Single copies 1 cent.
Subscriptions within the Boston Postal District and outside of the United States must be accompanied by postage at the rate of one cent a copy.

Printed by Puritan Linotype, Boston, Mass.

BOSTON, MASS., JANUARY 15, 1910.

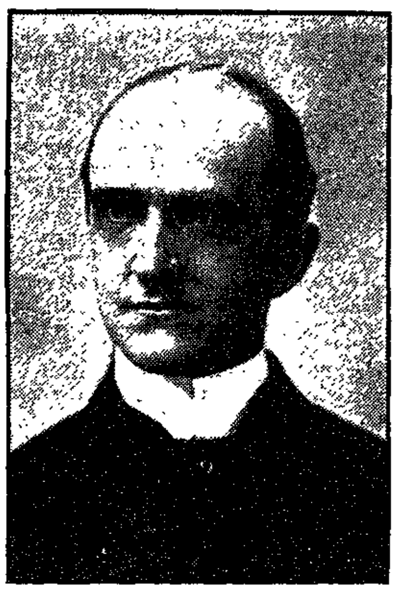
Although miners' work takes them underground, that they are not all dead ones is proven by the number of Course III men taking part in student activities. Among the seniors, the president of the class, one of the executive committee, two of the athletic association, the manager of the basket-ball team and others are prominent in outside work. Of the juniors, the clerk of 1911, and one man on the athletic association, the treasurer of Technique, the history editor of the year-book, as well as the business manager of the Tech, represent Course III. With the second year men, a miner is on the executive committee, and several are on the Tech. Besides these activities, Course III is always represented on class and varsity athletic teams, musical clubs, etc.

COURSE IN GEOLOGY.

(Continued from page 23.)

maps of the State. The United States Geological Survey stands ready to co-operate with the State in the expense of making these maps. The Institute of Technology ought to provide some of the topographers for this work if it is carried out. There is always opportunity on the geological survey for undergraduates or graduates of tne Institute to get profitable training under the skilled Government topographers. Course XII. is designed to develop systematic training along these lines.

The geologists who graduate from the course in Mining Geology at the Institute, may enter upon any one of several different professional careers. They may become Government or State geologists, do private expert work along economic lines, or become teachers in colleges. The usual procedure of our geological graduates is to go at once into a mining district, and begin work from the bottom up. Some men take the civil service examination for a position as assistant geologist on the United States Geological Survey, or become assistants on the Geological Survey of Canada. There is to be an examination held in many cities all over the country,



PROF. T. A. JAGGAR.

now announced for February 16th and 17th, to provide candidates for vacancies on the geological survey at salaries ranging from $1000 to $1600. The men chosen will have opportunity to gain valuable experience in remote and wonderful regions, such as Alaska, the Rocky Mountains, and the deserts of Nevada. Such experience is a training school in itself, and the Government offices provide every facility for excellent work at great expense. Men who have worked on the survey for a few years frequently go into private practice as consulting geologists, or become consulting experts of great mining companies at salaries ranging from $5000 to $10,000, according to their ability. The geologist is becoming more important in the commercial world as his science gains definition and accuracy; and nowadays there are many uses for his work apart from ining. In connection with water supply, sewage disposal, railroad engineering, harbors, agricultural and soil surveys, irrigation, forestry, and landscape architecture, and many branches of engineering construction, as well as in matters of litigation concerning the earth and its products, the services of the geologists are constantly required.

BLAST FURNACE.

HISTORICAL OUTLINE

By PROF. R. H. RICHARDS.

Rogers laid out a program for a course in Practical Geology and Mining in his early pamphlet (Scope and Plan of a School of Industrial Science, May 30, 1864). It consisted of suitably balanced chemistry, physics, and mathematics, with geology, mechanical engineering, and civil engineering, together with language and literature; and to introduce the student to the practical side of the profession there should be a laboratory for concentrating and smelting, and also assaying by fire, and finally visits were to be made to mines, concentrating mills, and smelters. Rogers also gave the instruction in geology and physics during the first five years in addition to his duties as President.

Runkle in 1871 organized a summer school to visit mines, mills, and smelters in Missouri, Colorado, Wyoming, Utah, Nevada and California. Through his zeal and energy the Institute was presented many ore samples from the mines, and a complete gold mill for stamping, amalgamating and concentrating gold ores by the San Francisco manufacturers of machinery, the Union Iron Works, and Joshua Hendy Mfg. Co.

Ordway built the first metallurgical laboratory, including assay muffle and crucible furnaces, a roasting reverberatory furnace, a smelting reverberatory, and a little brick blast furnace for smelting.

Storer was the chief teacher of chemistry in the early years. Eliot followed by Allen and Ordway in Metallurgy, Henck in civil engineering, Watson in mechanical, Bocher and Kraus in languages, Runkle and Osborne in mathematics, and Atkinson in literature. Hague and afterwards Rockwell were the first two professors of mining engineering.

Richards in 1871 was placed in charge of the development and management of the mining and metallurgical laboratories. He also taught during different periods chemistry, mineralogy, mining engineering, and metallurgy.

The department has been very fortunate in its assistants, instructors, and professors throughout its history. The following men have risen through various positions in the instructing staff and have all contributed substantially to the development of the department: Stafford, Foster, Beal, Wood, Clark, Lodge, Hofman, Locke, Bugbee, Hayward and Reed.

The division of the subjects at present is: Richards and Locke have the mining and ore dressing, Hofman and Hayward have the metallurgy in all its branches, and Bugbee and Reed have the assaying and a portion of the metallurgical laboratory.

YELLOWLEGS.

(Saturday Evening Post.)

Yellowlegs is young and foolish when he wanders out from school,
Thinks a mine's a proposition to be run by line and rule.
He can tell the grizzled foreman just exactly where he's wrong,
And the "errors of the shift boss" are his never-ending song.
What he doesn't know of mining isn't worth the while to learn,
He would teach the old hands better, give 'em hints at every turn;
He's the pinnacle of progress, he's the prophet and the seer,
For he's learned it all at college, has the mining engineer!

Yellowlegs is young,
Yellowlegs is new,
Give him time to find himself,
Time to change his view;
He'll come down a peg
When he's worked a year.
He's a bully boy at heart,
Is the engineer.

Yellowlegs gets slightly wiser when he's worked around a while,
When he sees a little merit in the other people's style,
Finds a thing or two in mining he admits he didn't know,
Laughs at "absolute opinions" that he held a while ago.
Then he buckles down to business—there is plenty of his own—
Lets the foreman and the shift boss fight their worries out alone;
For it slowly dawns upon him, and it dawns upon him clear,
It will keep him mighty busy just to be an engineer!

Yellowlegs is young,
Yellowlegs gets wise,
Finds he hasn't any time
Left to criticise;
All his uppish ways
Quickly disappear.
He's a bully boy at heart,
Is the engineer.

Yellowlegs has all the workings on a blue print paper plat,
He knows where this drift is going, where the latest stope is at.
It is Yellowlegs who figures when to raise, and how and where
To connect the different levels and to give the miners air;
How to cross-cut through the "country," how to raise a thousand feet,
So the shaft that he is raising and the one above shall meet.
And although we chuckle at him when he comes among us here,
He's a pretty wise gazabo, is the mining engineer!

Yellowlegs is keen,
Yellowlegs is cool,
After he is toned a bit
He's nobody's fool.
Mine would be a joke
'Cept with him to plan.
He's a bully boy at heart,
And a bully man!

—Berton Braley.

MINING ENGINEERING

By PROF. CHARLES E. LOCKE.

First of all, let us consider the various openings for a young man in the profession of mining engineering. He may have to deal strictly with mines, their investigation and working; he may have to do with the ore dressing side, which covers the separation of the valuable minerals from the waste; or he may go into metallurgical lines where he extracts the metal or useful material in such form that it is ready for the market.

In small mines a young man usually starts in as an assayer or surveyor, and works up to the position of superintendent or general manager. Such mines are often in remote places, in many cases their life is short, and, although progress is rapid, the frequency of change of location may become a serious drawback.

In large mines the whole operation is generally on a more permanent basis, so that progress, although it is along the same path as in small mines, is apt to be slower and surer. Such mines often have the advantage of attracting larger communities.

Coal mining is in a class by itself. These mines are generally large and work here partakes of the nature of manufacturing industries where a young man can start at the bottom and work up.

Metallurgical works are, as a rule, large and permanent and located near centers. A young engineer starts in a subordinate position, often as chemist. Iron and steel metallurgy requires enormous plants and involves considerable mechanical as well as metallurgical work. It approaches the nearest of anything in the mining line to a permanent manufacturing industry.

The foregoing are the main lines that are open. Others are government work, especially on the geological survey, mining expert work which should be attempted only after years of practical experience, the manufacturing of mining machinery, and so the list can go on indefinitely. A study of a list of graduates of a mining engineering school will show that the men receive such a broad training that their pursuits become many and varied.

In preparing to enter this field,—and this applies to all engineering professions,—honesty, courage, perseverance, firmness, self-control, a knowledge of, and an ability to handle men, are absolutely necessary. Honesty is placed first because the peculiar nature of mining has made it such a field for dishonest schemes in the past. The cupidity and gullibility of man, coupled with the uncertainty of the extent and richness of the earth's treasures, are the chief causes of this. Happily, conditions are improving and it is to be hoped that the day when all mining enterprises will be legitimate, is not far distant.

The technical training for this profession is broad rather than highly specialized. The mining engineer must not only be a master of his own subject, but he must combine with it a knowledge of other engineering professions. It may be well to consider the individual subjects and their relation to the work.

Mathematics, physics, and chemistry are the fundamental studies. Mathematics and physics are necessary in all engineering work. The former is required for all sorts of calculations and also gives the training which leads to exactness. The latter involves a knowledge of all natural laws without which an engineer would be hopelessly at sea. Chemistry, including fire chemistry or assaying, is necessary for the determination of the values in an ore or in the products of a metallurgical operation. In fact it may be said that metallurgy is dependent upon chemistry.

Mineralogy, or the knowledge of minerals, is essential in prospecting for valuable deposits and also in solving the problem of the proper treatment of an ore to recover the values from it.

Geology, or the knowledge of the earth's structure, is likewise of import-

PROF. C. E. LOCKE.

ance in prospecting. It comes into use also in actual mining work in deciding how to remove the ore to the best advantage.

Civil, mechanical, electrical, and hydraulic engineering are useful because the mining engineer in the majority of cases is located in a remote place where he cannot call in a specialist in these subjects without great expense and loss of time. He must understand mechanical engineering in order to superintend his construction work; civil engineering for his surface surveying and also for the surveying and mapping of underground workings; electrical engineering for the installation of modern power transmission and for the operation of electro-metallurgical processes; and hydraulic engineering for the best utilization of natural water power.

The consideration of academic studies—languages, history, and English—has been left until the last. Undoubtedly some very successful engineers have been able to get along without them, but their lack is a serious handicap to a man. One can readily understand that a manager writing reports or dealing with his superiors will be greatly aided by a good command of the English language. Similarly a commercial training would be very valuable in the keeping of accounts, buying and selling, etc.

It is claimed by some that four years at a college giving good scientific trainings, supplemented by two years at a technical school, furnishes the best preparation for a mining engineer. The former not only imparts a general education and broadness of view, but also in the majority of cases provides contcat with his fellows, which is apt to be missed in the highly specialized work of the latter.

One may ask how it is possible to turn out a mining engineer who shall know all about civil, electrical, mechanical, and hydraulic engineering in the same time that it takes to train a civil, electrical or mechanical engineer. The answer is that the student is given the broad principles and not the specialized work of all these lines.

The school education is only part of the training of a mining engineer. It must be supplemented by a course in practical work, an apprenticeship, so to speak, where he will gain a knowledge of details and of men and learn to adapt his theory to practical work. This practical work may either precede or follow the theoretical study, but the balance of opinion seems to be towards the latter sequence. Sometimes the two may be sandwiched together, and this course is to be commended. The question of how long or how varied this practical experience shall be will depend upon the individual case, and it is impossible to make any definite statement here.

The question as to which line offers the best chances of success is not capable of answer. It is the opinion of the writer that opportunities are good in all lines and it is not the training that a man receives, nor the line of work which he chooses which guarantees success, but rather the man himself. The best man comes to the front everywhere.

The salary which a technical graduate may expect to receive, is by no means fixed and, viewed in the light of what has been said previously regarding the necessity of practical experience, it will be seen that salary should not cut too much figure in choosing the line that one expects to follow. In a general way the salary varies in inverse ratio to the probable life of the position. At the present time metallurgical works offer beginners from $40 to $60 per month, while mining jobs will pay from $50 to $75 per month at the start. A good man, however, will soon get a raise from these figures and will continue up the ladder until he finds himself at the top among the mining and metallurgical experts, and the presidents, general managers, and superintendents, whose yearly salaries run into the tens of thousands.

MIN. ENG. SOCIETY

By ROBT. S. BREYER 1910.

The objects of this society as set forth in its constitution are to awaken and maintain an active interest in the study of Mining Engineering among its members and to aid generally in their intellectual advancement and improvement.

With these objects in view and with the realization that there existed an urgent need of such a society, a committee of three was appointed in the fall of 1897 by the classes of '98, '99 and '00 to look into the formation of a society and to draw up a constitution. This they did and the constitution was finally ratified. The officers elected, who had previously composed the committee, were: President, Arthur L. Hamilton '00, at present a mining engineer at Fairbanks, Alaska; vice president and treasurer, Stanley Motch of the Motch & Merryweather Machinery Co., Cleveland, O.; secretary, Edward E. Bugbee, at present assistant professor of mining and metallurgy in the department.

At this time the society was an entirely new venture, but from the start it was shown that a long felt necessity had been met, namely the furnishing of means whereby the undergraduates were put in closer touch with one another and with men engaged in actual practice.

It is worthy of note that the first speaker was the prominent mining engineer, Bradford H. Locke, III., '72, who was more than well qualified from actual experience to "warn the future mining engineers from the Institute of the many pitfalls that meet the mining engineer in the way of mismanagement, temptations to dishonesty, mine salting, etc., when he goes out into the world to begin the battle of life"; and that the absolute essential and therefore axiomatic qualities of a mining engineer are that he must be both honest and competent, points which have been brought out from time to time by engineers who have addressed the undergraduates.

The present society has a total membership of ninety-three (93) active members, drawn from the three upper classes. It will be noticed that the society has departed from the usual custom of admitting only juniors and seniors to membership in a student professional society. However, this step of admitting sophomores was not taken with the idea of increasing the membership, but with the idea that the advantages of the society should be extended to all those intimately connected with the department. And, furthermore, it has been found of advantage to admit the sophomores, since by doing so a closer relation between them and the department is set up, and again the knowledge gained in the meetings, of the practical side of mining and metallurgy proves of great value in the first summer position for a certain amount of practical experience is now urged and may become made a requirement of the department in the near future.

ORE EXTRACTION

By PROF. CHARLES E. LOCKE.

In another article mining engineering has been discussed in the broad sense and it remains here to discuss it in the restricted sense, namely as covering only the extraction of the various ores from the ground. This course runs throughout the junior year and instruction is given entirely by lectures. The practical acquaintance with the subject may be obtained in summer school or by work in mines during vacations.

As an introduction to the course a few lectures are devoted to mechanism and machine parts so that the student may listen understandingly to descriptions of mining machinery later on. Likewise a few typical ore deposits of the United States are described so that a man may have in mind the conditions which govern the use of different methods in different places.

Next under prospecting are covered the indications of ores and the tools used in rotary drilling (diamond drill) and in percussion drilling for determining the character of the ground to depths of even 4,000 or 5,000 feet.

Under tools for breaking ground are hand tools, rock drills, compressors, coal cutters and explosives. Methods or drilling and blasting are discussed.

Under the supporting of excavations are covered life and preservation of timber, masonry, cement, framing of timber, excavation by use of shields and shaft sinking by special processes in quicksand and other soft running ground.

Forms of mine workings are very numerous, depending on the ore deposit. Typical examples are given of quarries, open pits, shaft and level system for metal mines, and coal mines of both the bituminous and anthracite variety; also special methods for large ore bodies like the iron mines of Lake Superior and the operation of washing auriferous gravel, both by the use of hydraulic jet of water and by the use of dredges.

Haulage includes cars, rails, man tramming, the use of horses and mules, steam, electric and compressed air locomotives, wire rope cable, arrangement of tracks and aerial tramways.

Hoisting is effected by hand windlass, by horse and by hoisting engines which may be run by steam, compressed air, gasolene, water wheel or electric motor. Numerous types are described and attention is given to the parts such as drums, brakes, clutches, indicators, etc.; also to hoisting ropes, buckets, cages, skips, head frames and plant at the mouth of the shaft.

Under drainnage and pumping come dams, drainage tunnels, hoisting water in tanks, and pumps of all kinds, including Cornish rod pumps, direct pumps, centrifugal pumps, rotary pumps, etc.

Ventilation includes a consideration of mine gases, and apparatus for supplying fresh air to the miner. Closely allied to ventilation is the subject of explosions, their cause and prevention and the same for mine fires.

There are numerous other subjects which are included under mining. These are the lighting of mines; the methods used for ingress and egress of the miners; mining laws which govern the acquiring, holding and operation of metal mines, coal mines, tunnel sites, mill sites, water rights and placer ground; the handling of workmen and provisions for their comfort and improvement; accidents in mines their cause and prevention; the examination of mines to determine their value; underground surveying; the keeping of accounts and the making of reports.

From the foregoing it will be seen that the ground covered makes the course of necessity a descriptive one and there is little time for problems or for a detailed study of many of the operations. An advanced course in mining is offered to students who wish to go further into details and also spend some time in working out problems in connection with a mine plant.

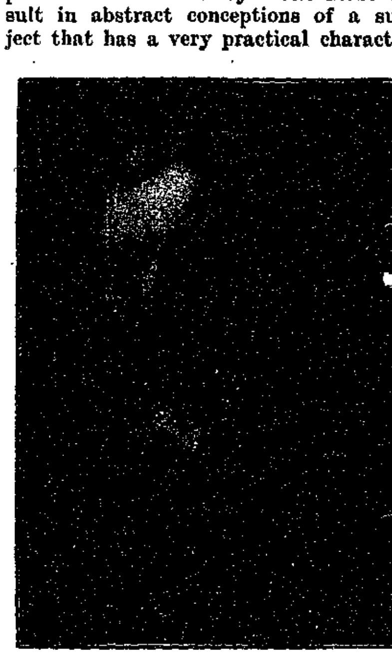
TEACHING OF MINING

By PROF. H. O. HOFMAN.

The question is often asked by students in the Department of Mining and Metallurgy if it is not advisable to go to one of the old-established mining academies or to the new technological institutes of Germany which give courses in mining and metallurgy, and follow there some general or advanced course and thus round out the technical education received here at the Institute. The present issue of The Tech forms a good occasion to bring this matter before the students of Course III.

The Institute receives its students from high schools and aims to give them a general, as well as a technical education; in fact, two of four years assigned to a course are taken up with general and auxiliary studies, leaving only two full years for really professional work, and some part of this time is devoted to studies that are not strictly professional. It is evident that the professional time cannot be so extended as is the case with the four years of a German technological school, in which no general studies whatever enter the programme. In fact the German has finished his general education in the gymnasium, comparable in quality to the Latin high school, or the Realschule, similarly comparable to the English high school, before he enters upon his technical studies; the German technical school, as well as the university, is a post-graduate institution. The graduate of a German Realschule is through with English and French, he reads these languages with comparative ease and writes and speaks them somewhat; he is familar with the political history and geography of the world, in mathematics he has included differential calculus, he has had his courses in general physics and chemistry and has gone far enough in qualitative analysis to begin with quantitative. In fact, as far as his positive acquirements go he is in line with the average college graduates. The consequence is that the technical school can begin where the realschule stops.

The aforesaid would lead one to believe that starting with such well-prepared students, the courses of technical instruction in Germany would be on a much higher plane than are ours, and our graduate could not do better than go from the Institute straight to Germany and obtain there that advanced training which would prepare him so much better for his professional career than his colleague who staid at home and went straight to work. It is true that many technical courses given on the other side are of a more advanced grade than those given with us, if by advanced we mean theoretical; others, however, and most of them dealing wit' mining and metallurgy, simply cover the field in a larger way; the subjects are developed historically and much time is devoted to this side, but the time given to modern methods is not greater than is the case here. The German thus gains an historical perspective for which we have not the time. When, therefore, the essentials as to the present and future practice in mining and metallurgy are concerned, the German student stands about on the same footing as the one at Technology, only the German has a larger background and perhaps therefore a firmer foundation. There is, however, another side. German instruction in mining and metallurgy is exclusively by lecture, the laboratory is practically non-existent. The German professor develops his subject systematically in his lectures, the student absorbs what he can, and studies the rest from the numerous treatises that have been published. When the lecture is finished the responsibility of the professor ceases. It is the student's duty to study these lectures and acquire knowledge as best he can by himself. It is easily recognized that courses on mining, ore dressing and metallurgy without the accompaniment of laboratory work must result in abstract conceptions of a subject that has a very practical character.



PROF. H. O. HOFMAN.

The great gap that exists between the theoretical and practical aspects of technology matters with a strong leaning toward the abstract, forms the weak point of German technical instruction. We on our side sin somewhat in the opposite direction, in that we look too much at practice and not enough at theory; but our gap between the two extremes is small.

In recent years some of the German technical institutions have been accorded the privilege of awarding the degree of Doctor of Engineering to the regular graduates of technological schools after they have taken a post-graduate course of two years and prepared a thesis embodying a research which takes up most of the available time. The results of this work along metallurgical lines are seen in the splendid dissertations printed in the technical literature.

The teaching of the German schools may be said to accomplish two results, the training of an administrative engineer and of a theoretical engineer well qualified to advance his profession along scientific lines. It does not train the all-round man who is prepared to meet all sorts of emergencies, such as the practical engineer is sure to encounter in his profession in this country.

If the work demanded of the German and American professors be compared, there will also be found a considerable difference. A German can become a full professor only after having excelled in a special line of study. His whole pre-professorial life is therefore centered on becoming the authority in one specialty. The duties of lecturing take little time; the whole working power, which is really great, is bent upon exhausting a subject by investigation and by publication of the findings. The result is that unending stream of German publications in technical matters of which the conscientious, untiring thorough work of the young doctors of engineering carried on in the research laboratory, forms a considerable part.

In this country the leading duty of the professor is to teach the students, not simply to impart, but to see to it that the student learns what is being presented. He has, besides the class-room teaching, the laboratory teaching; further, he has to serve more or less in some administrative capacity or other. Very little incentive is given him for independent research work. If, nevertheless, he does an astonishing amount of it, it is accomplished only by working under high pressure if he is to meet on one side the official duties as a teacher and administrator, and to satisfy on the other the inward impelling force that drives him to make his contributions to the advancement of his profession. We see here, therefore, fewer contributions to the advancement of engineering than in Germany.

Given the conditions of work in both countries, is it advisable for a young graduate in mining and metallurgy to go abroad and study for a year or two before he enters his career here at the foot of the ladder? By way of introduction, the fact may be noted that from 1873-1877, when the writer was a student at the Royal School of Mines at Clausthal, Prussia, about one-half of the students came from the United States, and that when the old school was visited in 1890 not a single American was registered, but the foreign element was represented mostly by Englishmen, while the Germans were in the great majority. Similar conditions prevailed at the other famous school of Freiberg Saxony. The simplest explanation for this phenomenon is that the American had found in the meantime at home what was required and did not feel the necessity of going abroad. In the great majority of cases, this conclusion holds good today. For the small minority there are perhaps two clear cases. One is, that a student has been graduated at an age of say 21 or 22 years and has the means of passing one year in Germany. The advice to him would be, go by all means, you will learn the language, you will see different ways of attacking technical problems, you will get into different surroundings, be subjected to new influences, in one word, you will return a broader man and thereby better suited for your future career. The other case is one of a young graduate who has been at work in a branch of his profession for several years; he knows the practical side of it, has also carried on enough original research to be able to work independently. If there is at one of the higher institutions of learning in Germany a professor whose specialty is in line with the branch of the profession that the young man is following, the advice is to go to the professor and work in his laboratory, he will receive you with open arms and you will make a tremendous progress in your special branch of metallurgy.

GRADUATES LETTERS

To the Editor of The Tech,

Mass. Institute of Technology.

Dear Sir:—Down here in southwest Missouri we have ideal conditions for mining. The climate is favorable, as there is no severe weather in summer or winter. Although the thermometer keeps around 95 degrees during the summer months, the nights are always cool. There is no danger of the fever, or unhealthy conditions which surround many mining camps. Joplin, a city of about 20,000, is the center of the camp. There is an interurban electric line which reaches nearly all parts of the city. This makes it possible for one to live very comfortably in town and yet be able to be "on the job" in the morning when the shift starts. I think these few remarks will explain why this country is an ideal one in which to mine.

It is a poor place for a man to come who is specializing in geology alone. The formation here is practically the same thoughout the entire district. Surface indications or outcrops are of little value in determining the value of an ore-body. Therefore, a study of geology helps a miner but little in either finding or tracing an ore-body after it is once located. As none of the deposits lie at a greater depth than 300 feet, drilling with a Keystone drill is used as a means of locating mineral in nearly all cases.

On the other hand, this camp offers great advantages to a man who wishes to learn the mining business from a practical standpoint.

Most of the ore is obtained from the "sheet-ground" deposits. As a rule these mines only carry from two to four per cent. of recoverable mineral. It becomes necessary then to mine as cheaply as possible. Large tonnage, as high as 1000 tons daily, are handled at a total mining and milling cost of under 80 cents per ton of rock handled. The labor is highly efficient, being entirely American. A foreigner is not tolerated here for even a day. There are no unions, so many of the labor difficulties met with in the West are avoided. The above reasons indicate what a good place it is to gain experience, as a man will gain first hand knowledge in a short time, of mining, milling, power and pumping problems.

The salaries paid are not as high as in the western camps, as the mines are not rich enough to stand fancy prices. A man coming down here with a good technical training will get from $75.00 to $90.00 a month his first year. After that he ought to be capable of superintending a small property, and such a position will pay about $125.00 a month. From this he can work up into more responsible positions, paying as high as $500.00 a month among the large companies. Opportunities are plentiful, however, for making money on the side once a man has established a reputation. Expert examinations are often called for, as well as advice on other questions relative to the mining game. Technically trained men are comparatively few, and are usually sought after, when it is evident they have learned and understand the conditions peculiar to the mining in this district. Another opportunity to make money here is in prospecting. There is much undiscovered mineral here, and as prospecting is not costly, with a little judgment a fellow is likely to strike a good mine. Of course it is more or less a question of luck, but it strikes me as being one of the advantages of the district.

To sum up, this district offers the following advantages: It gives a man a good opportunity to learn the business from the ground up, as he can start in at a small mine where he has to be ground boss, jigman, pumpman, master-mechanic, and superintendent all in one. He has a good chance to become an operator, as a good mine, when once found, can be developed on a few thousand dollars. He learns to handle an independent, although highly efficient class of labor. Last but not least, he has a pleasant home, and has not the hardships of the western camps. Living is fairly cheap, so he can marry if he wishes, and raise a family in surroundings as pleasant as the suburbs of Boston.

Very truly yours,

J. H. POLHEMUS 1906.

Salt Lake City, Utah, Dec. 15, 1909.

To the Editor of The Tech,

Dear Sir:—A perusal of the list of subjects offered in the courses in mining and metallurgy, as printed in the latest catalogue, gives the impression that an attempt has been made to supply such a broad foundation as the varied experience of the graduates has found to be most desirable. There must have been much discussion, and much compromising, before the details were settled, for no two men have the same experiences and the same needs, and during the few years immediately following graduation each man is inclined to suggest that more time be given to that particular subject in which he has found himself lacking. Thus the young graduate who is asked to help sharpen drills complains that he has not been taught this at the Institute, and the man who gets a position as chemist at a vanadium property feels that he should have learned the details of the analysis of vanadium ores. When I reported for duty at the office of a plant soon after leaving Tech, the manager said: "Go down to the pump station where the carpenter is putting some wooden cogs in the gear of the power pump; we have to shut down every other day on account of a break there, and I want you to find out what is the cause of the trouble." It was then that I wished I had taken the mechanical option. A few years later, when I was employed to lay out the development and equipment of a property on the coast of Alaska, it was stipulated that I should furnish a design for a wharf, with estimates in detail of the cost, completed, with necessary warehouses, and determine the best location for it. About the same time I had a letter from a man who wished to learn the value of a mine which had been worked years before, and had a shaft 200 ft. deep, with levels and stopes. After describing the property in detail he added this postscript to his letter: "Can you give me this information without having the mine pumped out?"

Based on these latter experiences I suggested to Prof. Richards a course in the study of ocean currents, and the use of the diving bell in the examination of the sea bottom, and of flooded mines. Naturally it does not appear in the new curriculum, because it does not belong there, though undoubtedly the knowledge gained might occasionally be useful. So might many other things which have been suggested. But four years is too short a period to afford time for study, or practise, of even one-tenth of the numerous subjects, a knowledge of which would at one time or another be of service to this or that man. Yet hundreds of Technology men have solved the new problems which have arisen because the Technology training fits a man for just this work. Looking back over an experience of nineteen years as chemist, assayer, smelter superintendent, mill superintendent, mine superintendent, consulting metallurgist, manager, and consulting engineer, I believe that the course now offered is well nigh the best that can be developed for undergraduates. The general studies, which were largely unknown to the '90 men, are along lines which everyone may find of value. Personally, I believe the study of Spanish should be made an equivalent of French and German. There are few engineers in general practice who do not have work in Spanish-speaking countries, and there are many opportunities for the young engineer in these countries to the south of us. However, another man may feel the same with regard to Chinese. And I believe it is a fact that a Tech graduate who took advantage of the opportunity to learn that language from his Chinese cook subsequently was selected to represent a big English syndicate in China, and later was officially "interpreter to Li Hung Chang."

No course could be devised which would present a tithe of the problems any one man will be called upon to solve. Each mine to be opened, each ore to be treated, is a problem unto itself, and the graduate must erect upon his Technology foundation a structure built with experience before he can become an engineer. When he leaves Tech he is only a "S. B." Perhaps some day, as do certain schools of the West today, Tech will confer, on those of her sons who have built worthily, the degree of "Engineer."

Sincerely yours,

G. A. PACKARD 1890.

To the Editor of The Tech,

Dear Sir:—Replying to your letter asking for some experiences, I feel that the best way to answer you is to tell briefly the work I have done.

After graduating in 1892, I accepted a position in the blast furnace department of the Maryland Steel Co., at Sparrows Point, Md., and started to work in the "monkey-wrench" gang in July, 1892. As a "learner" I was paid $40.00 a month for the first year, no matter what work I did, or how long I worked, though I did turn work before the end of the year that was worth over $60.00 a month. I worked as machinists' helper, pipe-fitter, oiler, pumpman, and helped to run and repair blowing engines and pumps. In the fall I put outside at the furnace proper, and learned to tend stoves and the hot blast. There was much hard, hot, dirty work, and more or less danger in this job, but as I was learning all the time I didn't mind it. In the spring I took extra turns as foreman, especially on night turn, with one of the older foremen. Shortly after a bad explosion at one of the furnaces I got my first promotion, and then inspected coke, limestone, and other ore, and did some experimental work around the blast furnaces. One job was to remove the "salamander" from the hearth of a furnace and recover the lead that had accumulated from some foreign iron ores (mostly from Spain and Seriphos). I even made an assay for silver in the lead.

In the summer of 1894 Prof. R. H. Richards offered me the position of private assistant to help especially in the preparation of his "Notes on Iron." Then followed over a year of the most agreeable and useful work I ever did; the surroundings were ideal (I lived in the home of Prof. Richards) and my work seemed more like a post-graduate course than like earning one's living. In this work English, German, French, mechanical drawing, and laboratory work were all put to use, and I reaped the benefit of "Memoirs." After this came "Ore Dressing," and "Mineral Industry," and perhaps by this time I would have been on the staff of some technical school if I hadn't taken the first chance to get back to the furnaces.

In the short-lived boom of 1895 I went back to Maryland, this time as assistant superintendent, and I stayed till October, 1896, when there was another shut-down. This time I got experience in burdening the furnace, and in running the plant by myself. Being out of work again, I returned to Prof. Richards, and worked on his books and experiments with him.

Late in December, 1896, I took an offer to go to Everett Furnace, Bedford, Pa., as assistant superintendent under J. E. Thropp, Jr., M. I. T. 1894, who was superintendent of his father's blast furnace and ore mines. The following September Thropp, Jr., was made general manager of the furnace, mines, coal and coke works, and I was made superintendent. Then followed a year and a half of hard work and long, long hours. In the spring of 1899 I wanted more money and a change, so I accepted an offer through G. F. Knapp, M. I. T. 1884, and went to Seetonia, O., as assistant to the president of the Salem Iron Co.

The furnace plant of this company was being rebuilt and improved, and I had much engineering and construction work here. I looked after contracts and did the purchasing, and also got some excellent experience in office work. Again, Mr. Knapp recommended me to a better place, and in June, 1902, I went to Johnson City, Tenn., as General Manager of the Cranberry Furnace Co., in charge of their blast furnace in Johnson City, and their famous Cranberry ore mine in Mitchell Co., N. C. Now came mining, ore-dressing, magnetic concentration, transportation, water power, diamond drilling, and many other mining problems, besides the cost sheets, correspondence, banking, commissaries, and office work.

In the summer of 1904 I went to Sault Ste. Marie, Ontario, as superintendent of the blast furnace of the Algoma Steel Co. One furnace was the largest charcoal blast furnace in the world, and we made some new records for charcoal furnaces. Climatic conditions developed suitable equipment for this northernmost furnace, and there were many new experiences.

A very favorable proposition, with prospects of permanency brought me back to the States in November, 1907, to my present position, where there are special problems in water supply and purification, and in fuel economy and labor-saving devices. My attention has been especially called lately to metallurgical questions concerning blast furnace practice; chiefly regarding increased output, fuel economy, regularity of product, and safety in operating modern furnaces.

There is a demand for technically trained men who can get results out of blast furnaces, and there is still a broad field for investigation and improvement in blast furnace metallurgy. The rewards are ample for those who will do the work, and I have found that a man can double his salary every four years if he doesn't live too long. There is great satisfaction in making new furnace records, and then beating them again; it is a game that when one wins all the others gain too, and there is satisfaction all around.

Yours sincerely,

R. H. SWEETSER 1892.

One of the many thoughts which come to a man in his professional work just after leaving college is the recollection that he has left undone many things he should have done; and, on the other hand, done many things he wishes he never had. He regrets, perhaps, that he pursued a certain subject diligently which he does not use, and passively neglected other work which is now of paramount importance to him and which gives him many nights of study and care in order that he may hold his job as a Tech man should. The moral is obvious: Clinch every professional subject in your course so well that you are able to apply your knowledge at any time,—for you may be reasonably certain that the unexpected will be just what you are expected to do.

What I have just referred to concerns the preparation of a prospective engineer,—the hardest problem that faces the "educational engineers," the teachers in all our technical schools. What follows is not going to be a thrilling story of dangers met and overcome and fearful experiences of the "Soldiers of Fortune" type,—because these are generally creatures of the imagination, and because no experience is so terrible after it is over,—but a few lessons learned that have remained long after the incidents which created them.

First, forget that anything like a watch or a clock exists to you. Do what is expected of you as soon as you can, and let "quitting time" mean that the particular thing you have in hand is finished, whether it be the closing line of a survey, a calculation for a beam, or the examination of a distant outcrop. I have worked with men whose creed was "knock off at five," who wondered why their pay was not raised oftener, and who forgot that "pull" and "push" are the expressions of the same force,—but opposite in direction.

Willingness and confidence are great assets. Some men dislike to do certain jobs that come up in routine work. Don't show this to your superior because he may find it convenient to hunt out similar things for you to do in an effort to try you out. Be confident in yourself. Tackle your problems squarely and when you find yourself in trouble go to the man who knows for assistance and you will get it. Above all, don't be afraid to acknowledge a mistake; you will find that you are better liked for it than if you tried to hide your error by subterfuge.

Cultivate the habit of correct speech and writing. Every engineer is called on to make reports, on one kind or another, in writing, and sooner or later he will be asked for an opinion or an explanation. He should always be ready to clearly outline on paper his suggestions or conclusions, and should be equally prepared to stand before a body of men and intelligently express his ideas. The engineer then becomes more than a mere unit in a system,—he is endowed with personality and that personality finds its expression in his written or spoken thought.

These thoughts are not given as any indication of what one's future professional life may be like, but rather as a suggestion, drawn from a short professional experience, to the prospective engineer, who will make the same mistakes and learn the same lessons that every one of his predecessors has made and learned.

JOSEPH DANIELS 1905.

WORK OF ALUMNI

By MR. H. R. BATCHELLER.

There is no engineering profession that so absolutely requires such a diversity of scientific attainment as does that of Mining Engineering and its associate and inseparable companion of Metallurgical Engineering. A perusal of the articles in this issue of The Tech will give the prospective Mining Engineer a clear outline of the essentials of his profession, and if his courage is good or his convictions positive enough to choose it. he will be amply rewarded in a profession combining within itself all the mathematical and natural sciences in an infinite variety of application and adaptations.

Not all the Alumni of the Department are called upon to commercially perfect, or industrially apply, more than a few of the several sciences included in the scope of Mining Engineering, but it is very necessary, for the full understanding of any specific detail of an operation, that the engineer have a broad general knowledge of the other problems involved that the complete sequence of operations from mining of the ore to the marketing of the metal may be kept in good and true proportion.

In the early days of the Department many, if not most of the Alumni went into the iron and steel industry in the United States, as that was the first industry to call for trained men. To-day other metal and mineral industries have felt the need, and now our men are in all parts of the world. From South Africa to Alaska, from China to the Philippines, come reports of our men who are identified with the industries in those countries.

A good rule to follow is to do the work of your position thoroughly, and at the same time study the work of the position ahead of you. The failure to do the first will obviously cause a severance of your connection with that job and nothing is more unreasonable than to expect promotion which must be followed by instruction in the rudiments of the new position.

An opportunity to make one's self useful about a mine or mill or smelter at a living wage for six months should be welcomed by any graduate of any institution, and I do not think Institute men as a rule require so long a time.

Some schools turn out finished assayers, smelter chemists, chemists, surveyor's helpers, etc., and these men at the start usually command as much or greater salaries and more comfortable positions than our men; but when measured up after an interval, Tech alumni will be found in the lead. The broad scope of the professional training obtained at Tech counts in the long run.

Some of our alumni who have gone out looking for a chance have been contented with day labor at $3.00 to $3.50 per shift, at hard work with "muck stick," or as helpers in various positions underground or on the surface. Men going into "staff" positions as assistant to the assayer, chemist, or surveyor or elsewhere, can usually expect $75.00 per month to commence on. At these wages a man can more than keep himself, even in high-priced camps like Butte or Phoenix and in the smaller and more remote camps he can live as well as he needs to or as well as the district will allow.

It is an open question which start is the preferable. An assayer must round out his experience by contact with other portions of the operations, and a "muck stick" starter should lay his trail through the assay office. Some graduates are in favor of one, some favor the other; both have been tried with successful final results.

Subsequent salaries, as far as I can learn, have been satisfactory, and after a few years our men have been holding responsible and well-paid positions with the end "not yet in sight."

The men who go to large companies have, as a rule, rather a hard time of it at the start. They are herded into all sorts of routine work and are in keen competition for each promotion. The positions, however, are usually so well within their capabilities that they have considerable time both on shift and off, which, with the run of the plant that is given them, the have magnificent opportunities to see and study large scale operations and have the latest and best of practice.

Those men who go to small companies usually as assayist or chemist have in very many cases a fine chance to study negative results, i. e., to see how things should not be done if money were not lacking or if ore bodies did not occasionally disappear or fluctuate violently in value. Their ingenuity will be taxed to the utmost to keep things in approximately proper operation with nothing but a scrap heap to draw on. All sorts of conditions arise that are simple of solution if funds are not lacking but which become very annoying when improvement of practice, effecting even the operation of the whole plant, must be made with no cost for new material or machines.

Some of the experiences of young graduates are very amusing when looked at afterwards but may prove to be very trying at the time. One man of my acquaintance who was holding his first position after graduation with a small but well equipped proposition, was very much disconcerted when directed by his "Old Man" to change the revolution of the electric light engine. The engineer-fireman did not know how and neither did the "O. M." The "assayer" had to make good on this and did so well that later he was called on to reset the valves on the mill engine.

One of our men who was working as a helper underground was changed to the assay office of a sixty stamp mill and concentrator on a moment's notice and was expected to keep things moving along without interruption. Another time he was called upon to assist at the clean-up and to prepare the bullion for shipment.

Another assayist on his first job was much distressed to find that his predecessor had been fired because he could not obtain check results when weighing gold assay buttons on analytical balances and was much disgusted when he at last obtained the desired new balances to find them the most expensive and most delicate that could be obtained and that the "O. M." declined to go to the further expense of a suitable room and foundations for them. The assayist continued to measure the buttons with a Plattner scale and finally lost his job because there was an accumulated discrepancy between the assay extraction and the mill extraction.

An engineer reporting on a mill process found that the bullion shipments were invariably excess of the extraction based on assay by a considerable amount. When this condition of affairs was corrected the directors strenuously objected to the change as involving explanations to the stockholders and the engineer was instructed to return to the original system of sampling.

A very interesting piece of work was done in connection with a cyanide plant in Mexico where it was found that the value of the stamp mill tailings to be treated was materially improved by the removal of the "slime" which interfered with the percolation. It was found that in order to report a maximum tonnage crushed any discrepancy in the quantity of ore mined was made up with what was known to be barren country rock. When this practice was stopped there was quite a reduction in operation costs and a material improvement in the values recovered.

It would be a very large volume that would contain all the experiences of all our men. The foregoing will serve to illustrate the variety of the demands made on the engineer and indicate the interesting situations and problems that continually arise.

THE MINING COURSE.

(Continued from page 23.)

chemistry and gas analysis and finally a thesis.

The course has recently been rearranged and is believed to be in better shape than ever before. There is a prospective change which will come whenever the corporation sees its way clear to transfer the instruction in surveying from the second year to the summer. This will give a better course in this subject and at the same time free some hours in the second year for other subjects. There is, moreover, a demand from some of the graduates for instruction in Spanish, which is the national language of the majority of American countries south of the United States. Formerly a course in Spanish was offered as one of the general studies of the third year, but last year it was stricken from the list.

GEOLOGICAL RESEARCH.

(Continued from page 23.)

vestigation as distinguished from mere geological information. The large corporations have found this out and are now drawing away from national geological surveys many of the men who, after years of research, have attained this masterly gift of directing expenditures with understanding. Taking little for granted, these men attack every ore-body as a new subject, and their scientific method is showing fruition in dollars and cents.

The Institute has always stood for this principle. Its first president, before he took office, was already famous for his studies on the structure of the Appalachian Mountains, and he always used his powerful influence in developing organized schemes for similar structural and dynamical studies. Artesian wells, mineral springs, subterranean temperature, earthquakes, infusorial earths, rock-weathering, coal deposits, and iron deposits in turn received his attention. His researches took him to West Virginia, Maryland, Pennsylvania, Ohio, Massachusetts, Rhode Island, New Hampshire, Maine, New Brunswick, and Ontario; and much of his thought was devoted to helping his brother, H. D. Rogers, to plan and execute the first

PROF. R. A. DALY.

surveys of Pennsylvania and New Jersey. Besides numerous separate papers Professor T. Sterry Hunt described his geological investigations in two thic volumes, the one on "Chemical and Geological Essays," published in 1874 at Salem, the other on "Mineral Physiology and Physiography," in 1886 at Boston. Similarly, Professors Niles and Barton stimulated their own thinking and enriched their lectures at the Institute by original work in the field. Professor Crosby's "Contribution to the Geology of Eastern Massachusetts," published in 1880, is a most remarkable book, which is still the only existing comprehensive treatise on our local geology. In his long years of work, Professor Crosby has shown a true genius for able observation and careful reasoning, and his place is among the soundest geologists this country has ever produced. His "Geology of the Boston Basin," in four volumes (called "parts"), the last of which is about to go to press, is a storehouse of information practically unrivaled for any area of similar size in Eastern North America. The accuracy and completeness of his field observations are little less than astounding to anyone who carries into the field one of these volumes as a guide. His energetic spirit has led him to study field problems in all of the other New England States, in New York, North Carolina, Eastern Canada, Colorado, South Dakota, Arizona, Alaska, Cuba, the Island of Trinidad, and other regions. Many important papers on theoretical geology have also come from his pen, and in them all one notes the same clearness of judgment. It is just because he has thus broadened and deepened his knowledge of geological principles that Professor Crosby is so valued an adviser to metropolitan water boards and to mining companies. A still more important result is that he has long been an inspiration to his colleagues and pupils who are engaged in the hard but repaying work of making earth-science of practical scervice to man.

Without other illustrations from the record, it appears that the Institute's tradition has strong sanction. For the future a high aim should be ours,—that every student, bachelor as well as master or doctor, leave the Institute an investigator for life. The spirit of research will be a greater asset to him than the mere acquisition of knowledge; it will carry him through many a difficult place which instructors cannot foresee, and in the end will reap a large reward.

SUMMER WORK

By EDWARD T. ALMY, JR.

On account of its situation in a city, and in a part of the country where no mining is done, Technology is unable to give any practical underground mining to the students in that course. The student can, if he wishes, devote the whole or part of his summer vacations to practical work, thereby increasing his knowledge of mines and mining methods to a great extent.

If a student is going to do summer work he should go into it with the idea of doing his best work, thereby helping to uphold the Institute's good reputation, and should not expect a manager's position the first summer. The positions which a man can fill after his third year in the course are not very high up the ladder, and are such positions as mucker, machine helper, machine man, assistant assayer or assistant surveyor, trammer, etc. These positions all require hard work; for example, a mucker has to pick and shovel ore from eight to ten hours per day, depending on the length of the shift at that particular place. If he does this well and seems to want to learn, after a month or more he is made machine helper. In this capacity he brings sharp drill steels to the machine man, carries out dull ones, puts in and takes out bits in the drill, and makes himself generally useful. If he is working with a good machine man he will be allowed to crank the drill occasionally and in a short time he is able to run the drill himself without jamming the steel too much, or poking out one of the cylinder heads.

After this, if there is a vacancy, he may be made machine man. In order to hold this position, however, he must be strong bodied, must know how to drill the holes, how to load and fire the shots, and must always be calm and level headed. Through all these promotions the salary is advancing, the salary at the beginning and the advance varying in different camps.

While he is at the mine he eats and sleeps with the rest of the miners, eating in the big dining room, and sleeping in the "ram pasture" or room with from ten to thirty beds in it, each holding a tired miner, and every one trying to outdo his neighbor in sawing wood. The new man soon gets used to it, and after his shift underground is generally tired enough to sleep anywhere. Some mines have abolished the "ram pasture" and the bunk house is divided into small rooms, each one holding two men. This is the exception rather than the rule, and a man should not be disappointed if he does not happen to get such accommodations.

Financially, summer work is usually not a great success, especially if a person has to travel any distance to the place where he is to work.

There is another and much more important side to summer work than the financial side. This is the actual knowledge gained. The student goes to the mine with a vague idea of the different terms used in mining, and with certain pictures in his mind of the way things look underground. These ideas are gained from books or lectures and the pictures from ideal sections in the books. He finds, however, that when he gets underground things look entirely different from the ideal sections, and it takes him some time to fit the terms used to their proper places.

The summer's work is an immense help the following year in school, especially in lectures. Here the student is able to understand better the different terms used, and understanding them, his interest is kept up more than it might be otherwise.

When the man graduates, if he has had one or two summers' practical experience, he finds that he fits into the work better, and pushes ahead much faster than he would had he graduated and then started in to get his practical work.

ROUND TABLE AND JIGS.

METALLURGY

By PROF. H. O. HOFMAN.

Metallurgy may be defined as the art of extracting metals from the ores and of refining them and fashioning them for use in metal industries. In order to cover the field it is necessary to have a knowledge of mineralogy to identify the character of the ore, of chemistry and physics to recover the metal and free the product from impurities, and of mechanical engineering to give the metal or alloy produced the forms that are required by the trade.

The progress that has been made during the last seventy-five years in metallurgical practice has greatly increased the demands upon the metallurgist. Some fifty years ago, metallurgical establishments were small, the processes carried out were the outcome of many years of practical experience, the whole was an art with a slight infusion of science. The older metallurgists, however, were keen observers and by persistent endeavor obtained a practical insight into the behavior of metals aad metallic compounds that astonishes the more scentifically trained metallurgist of today when he determines by precision measurement the limits within which the chemical re-actions of the processes can take place. As late as thirty years ago, the main equipment of the metallurgist was a general knowledge of mathematics, physics and chemistry, with some mineralogy and perhaps a smattering of mechanical engineering in addition to an acquaintance with the metallurgical operations carried out in different works. This was sufficient for the European metallurgical plants of that date, small in size and working along beaten paths. With the opening up of the mining districts in this country, new conditions had to be met; the established European methods of ore treatment failed when transferred bodily to this continnent, they had to be adapted to new surroundings or, in many cases, thrown over entirely and new means devised to attain given ends. This required going more deeply into the general sciences. The high cost of labor became the cause of the introduction of mechanical handling of materials in place of the customary working by hand. The enlargement of individual metallurgical establishments and the concentration of metallurgical work in places centrally located for the receipt of ores, fluxes and fuels and for the distribution of the products, made it necessary for the metallurgist to become more familiar with mechanical engineering than was formerly thought necessary; competition forced him also to increase the yield of metal from his ore, to enlarge the duty of his apparatus, and to improve the character of his product.

In recent years electrical transmission of power has made it necessary for the metallurgist to have a training in the fundamentals of electrical engineering; the application of electricity to the treatment of ores and refining of metals calls for some knowledge of electro-chemistry. The modern methods of thermal measurement have made it possible to control processes to a considerable degree; this control has opened up a comparatively new field, the application of thermo-chemical considerations to metallurgical practice; lastly, the laws of solutions as applied to the constitution of alloys combined with thermal measurements, microscopical examination and mechanical testing have furnished the guiding line for the explanation of the mass of heterogenous information accumulated by years of rule-of-thumb practice and for future research in the attempts to improve the physical and chemical properties of metallic products.

The metallurgist of today, therefore, must have some knowledge of mechanical and electrical engineering, of electro-chemistry in addition to the old-established auxiliary requirements of mathematics, physics, chemistry and mineralogy to assist him in his special study of metallurgy; he must have made his own some of the fundamental teachings of theoretical chemistry and the microscopical examination of metallurgical products must not be new to him.

The Institute aims to give its students in four years a general and a technical training. Regarding the latter, this instruction can cover in the available time only the leading principles and illustrate their application in metallurgical practice by brief discussions of characteristic examples. The corner-stone of Institute-instruction, a combination of lecture and laboratory, is well represented in the metallurgical laboratories in which the student carries out the leading metallurgical operations with apparatus smaller than working-size, but always large enough to give quantitative results. The laboratory runs parallel with the lectures or recitation, thus one supplements the other; the weekly conferences held to discuss the class experiments or the research that is carried on by individual students, vitalize all metallurgical work.

The subject of metallurgy is so large that it is impossible to cover the whole field in any adequate manner within the time allotted to it in the undergraduate course. Of the two ways open, trying to cover the whole superficially or a part thoroughly, the latter has been chosen. It is therefore advisable for the student to stay one additional year after graduating and become thoroughly grounded in all the studies which form the foundations of modern metallurgical engineering.

The prospects of the graduate to find employment are good. There is a large field as to the character and place of work. Iron and steel, lead, copper, zinc, nickel and some of the minor non-ferrous metals are treated near the centres of civilization; the precious and associated metals are worked in the isolated locations where they occur. Employment in populated centres, where competition is large, gives smaller pecuniary reward than in mining districts proper. A graduate from the Institute, however, receives in either case, more than is required to make his living and to be independent. The future success, professionally as well as pecuniarily, depends largely upon the man himself and on the manner in which he meets the demands of his employers and the requirements of his surroundings.

METALLURGICAL LAB.

By PROF. H. O. HOFMAN AND C. R. HAYWARD.

The conception of having a metallurgical laboratory is in harmony with the general principle of teaching followed at the Institute. There was no precedent, something new had to be created. There existed assay laboratories, but investigations into ore-treatment on a laboratory scale had not been thought of, much less the placing of students in touch with the operations discussed in the class-room. The beginnings of the laboratory were modest indeed; assaying and ore-treatment were confined to the present furnace department in the "pit." In time the whole basement of Rogers building was occupied, the addition of a sub-basement division had become necessary. Any one seeing the crowded condition that prevails at present could easily recognize why the plans for the future call for three times the area occupied at present.

The aim followed in carrying out the work in a metallurgical laboratory is to make the student personally familiar with the leading metallurgical operations, to teach him their physical and chemical control, and to induce him to carry on independently metallurgical investigations. Until within about two years, work in a metallurgical laboratory was confined to ore-treatment. This branch has been fully developed here and has served as a model for most laboratories that have been erected since in technical schools, and there is hardly an institution that has not followed the example of laboratory instruction set by the Institute. The second branch of metallurgical laboratory work, the study of the constitution and physical properties of metals and alloys and their changes as effected by heat treatment and mechanical working, is not as yet as fully developed as the first, on account of lack of space, but the facilities offered under the present cramped conditions compare favorably with those given elsewhere with institutions that started fresh with abundant space and facilities.

In the fall term characteristic metallurgical processes are carried out which embody the principal operations. The processes are worked quantitatively, in each of them the material going in is balanced against that which comes out; thus e. g., a complete account of stock of metal is taken showing the direct yield and the losses and their distribution; again a heat balance is made which gives an insight into the sources whence the necessary heat was derived and how it was expended; further there is prepared a statement of the materials consumed and of the labor and power required for a given treatment, and this furnishes the economic data essential for considerations of cost. Thus a metallurgical process is studied chemically and industrially also mechanically when this point of view forms an essential part of the whole.

In the class work the processes of roasting in hand reverberatory and the Brückner furnaces, blast-roasting, smelting in the blast furnace and the reverberatory furnace, converting matte, zinc desilverization, pan amalgamation and electrolytic refining of copper have been chosen as embodying the leading metallurgical operations with which every student ought to be familar by personal contact. Each of these processes requires a number of manipulations and observations, and every student does the necessary work and makes the records of his measurements. The individual records are then collated and the whole is presented to the class at the conference, called laboratory reports. Here the student sees his own records tabulated with those of the members of his section. The result of the work is analyzed and discussed.

In the individual work wet processes form the basis of study, as these permit the use of quantities of ore sufficiently small for the individual student to treat by himself. Thus, chlorinating, brominating and cyaniding gold ores, oxidizing and chloridizing roasting of copper, gold and silver ores in muffle-furnaces, and leaching silver ores with hyposulphite and cyanide solutions are carried through by every student. An ore is thus treated by a number of students, the treatment is the same excepting one variable, and this is changed in such a manner that when the individual tests are assembled and tabulated, the curve drawn will show the best conditions of working in regard to the variable quantity that has been under observation.

In the combined class and individual work, heat treatment and microscopical examination of metals, alloys and metallurgical products form the subject of study. Heat treatment and the determination of melting points are carried on in the heat laboratory in charge of Professor C. L. Norton. Every student does individual work upon his own specimens, each of which forms part of a series; later he polishes his specimens in the metallougraphical laboratory and examines them microscopically. The individual cooling curves are assembled to a freezing-point curve, and this is compared with the established curve. The student examines besides his own specimens, those of his colleagues as well as perfect specimens prepared elsewhere so as to compare his own work with that which is standard. He further makes sketches of the magnified surfaces seen through the microscope and thus fixes in his mind the structural features. Besides the specimens thus prepared by the members of the section or class, the microstructures of some of the leading industrial alloys are examined and their constitutions explained in connection with the established freezing-point curves. Iron, steel, copper-cuperous oxide, copper-silver, lead-antimony, brass, bronze and one or two ternary alloys are thus brought to the attention of the students.

Work in the spring term is given over exclusively to individual research which usually forms part of the thesis required for graduation. The subjects are taken from the whole range of metallurgy, depending largely upon the preference of the individual student. They usually embody, the treatment of an ore by an established process, variation of an established process to suit a given ore, study of limits of chemical reactions in metallurgical processes, investigations into fuels, refractories and other re-agents commonly used in processes, tracing of freezing-point curves of metals, alloys and metallurgical products with microscopical examination of polished surfaces.

AMALGAMATING PANS.

ECONOMIC GEOLOGY

By DR. G. F. LOUGHLIN.

Economic geology is, in its broadest sense, the application of the several principles of geology to problems affecting the welfare of mankind. It deals, therefore, not only with mining and quarrying, but also with various engineering undertakings, two striking examples of which are the water-supply development of New York and the building of the Panama Canal. The training of the economic geologist, even though it specializes, must be liberal, both in geologic and other subjects. Thus the mining geologist, in addition to his thorough acquaintance with ore and gangue minerals, must have a sound knowledge of structural and chemical geology and petrology and a fair knowledge of physiography and paleontology. Such knowledge to be adequate, can result only from careful and patient studies, both in the field and in the laboratory. He must also be familiar with the principles of metallurgy, surveying and economics.

The importance of structural and chemical geology needs little illustration. Without such knowledge it is in many cases practically impossible to follow and to work ore-bodies intelligently, to recover lost ore-bodies, or to estimate the amount and continuity of the ore. Some ore-bodies, for example, rich at the surface, are at slight or moderate depth, too lean to work; others, barren at the surface, may be rich at slight depth, only to become lean as depth increases. The composition of the ore, and its influence upon metallurgical methods must be appreciated in the field. Realization of the origin of ores is, in many cases, of vital importance in predicting the future of a mine.

Petrology is so closely related in mining work to structural and chemical geology, that the above illustrations could in part be repeated here. Where ores, as is commonly the case, are localized in certain kinds of rock, it is indispensable to successful mining that the extent of the ore-bearing rock and its relations to other rocks of the district be known. Petrology furthermore, is one of the chief assets of the prospector.

Physiography is a subject too often neglected by students of mining geology. Although it is of but little importance in many mining districts, it holds the key to the situation in others, for instance, the "ancient" placers of the Sierras and the modern placers of California, Alaska, and elsewhere. In Alaska the distribution and relative richness of placers has been understood from study of the changes in the development of river systems.

Paleontology, like physiography, may or may not be of vital importance to the mining geologist ,according to the district in which he is working. The reader will find illustrations of the use of paleontology in Prof. Shimer's article.

The courses in economic geology given at the Institute to students of mining engineering presuppose training in all the above subjects, as well as in other related studies. The students, with this preparation, are given a general knowledge of the principles of mineral deposits in lectures and conferences, and study specific cases in the laboratory. This general training may be continued by graduate work along certain chosen lines, and may be carried on in connection with government, state or private work.

The study of building stones is largely a practical application of petrology to the needs of architects and civil engineers. Though a subject of rather limited scope, it is especially one in which there is need of good judgment rather than hard and fast rules. The importance of the subject to architects is amply illustrated in the buildings of our larger cities, where disfigurement of many handsome specimens of architecture is due, directly or indirectly, to ignorance of the most elementary principles of petrology.

The needs of the civil engineer in construction work may in some cases be essentially the same as those of the architect, although they may be quite distinct. Stones of little use to the architect may be the best available for the engineer, as was the case in the building of the Ashokan Dam in New York State. The engineer should be acquainted not only with the properties of stone for building, but also with conditions ilkely to be encountered in the tunelling and other excavation of dif-

(Continued on column 4.)

SUMMER SCHOOLS

By PROF. CHARLES E. LOCKE.

No summer courses have ever been given in the Mining Department. For a few years assaying was offered as one of the summer courses to be given at the Institue, but a sufficient number of men did not apply to warrant the giving of the course. On the other hand the professional summer school has been a regular feature of the training for over thirty years. The object was to enable the student by visiting mines and metallurgical works to gain a practical knowledge of the subjects that were taught in the class room. This work has always been optional owing to the expenses involved ($75 to $100), coupled with the fact that a student who has to work to secure money during the summer time is robbed of at least a month's time. A required summer school would prove a hardship for some men and might even prevent a needy fellow from taking the mining course. The benefits of such a summer school are threefold: first and foremost, the knowledge gained by the student; second, the connection that is gained with the mines and plants visited; and third, the publicity that is given to the Institute by a party of instructors and students which in a series of years cover various districts within a thousand miles of Boston.

Summer-school trips are divided into mining and metallurgical, and have been taken in alternate years so that a man could visit mines one year and metallurgical plants the other. To derive the maximum benefit a man should not take a summer school until after his second year. Two plans have been followed on the mining trips, one to visit a small mine and make a detailed study of it and also get surveying experience with the transit and plane table, the other to travel more extensively and visit several mines getting a broad view of the operations at each. On the whole the latter plan seems best on the general principle that school training should give broad fundamental ideas and leave details to be learned in practical work after graduation.

The first summer school was held in 1871 when a party under Prof. Runkle visited Colorado and Utah.

In 1908 only two men applied but the school was held, nevertheless. The smaller the party the better is the instruction received by the men, but on the other hand, it is a question whether the Institute in its present financial condition is warranted in using funds for a small summer school which can be used to better advantage in other ways. In 1909 no men applied, and no school was held. In the future the school will be offered every year, but it will not be held for less than six men.

The cause of the diminution of numbers in the summer school is to be found in the increased number of men who secure practical work during the summer. At the present time statistics show that over ninety per cent. of the men in the graduating class have had practical work of some kind during their vacations. Ten years ago only a small per cent. of the men had had practical work at the time of their graduation. The department has made special efforts to secure this work and during the last summer was able to supply positions to all undergraduates who applied. Compared with the summer school this practical work has two advantages:—first it gives an income to the student instead of an outlay, and second, it is considered that a whole summer spent in practical work at one place is more profitable from every point of view than a visit of from three to four weeks to different plants. As for the future, one cannot say just how the whole matter will work out. It seems very likely that before long one of the requirements for graduation will be that a student either shall have taken a summer school or shall have spent a vacation in practical work.

The relation of school work to practical work is very important and may be adjusted in various ways. Our old system of a sequence of school work, graduation, and then practical work gave good results as shown by the present high positions of former graduates. The peesent system of school work mixed with practical work during vacation ought to yield even better results. Still another system which prevails in some places is to have a mine run by students in connection with school work. Students drill and blast, timber, survey and carry on all the operations of mining. This looks very attractive in-deed, but close examination shows that it can never compare with work in a commercial mine. This was well demonstrated by the Crocker Summer School held in Colorado in 1903 and participated in by Columbia, Harvard, Technology, and Yale. A mine was leased and operated by students under the supervision of practical miners. Although this was probably the most successful summer school ever held still it lacked one important essential namely, the atmosphere of work. This leads to the conclusion that the best combination is the school for theory, and work in a commercial mine for practice, the number of students in any one mine to be a very low proportion of the total men employed.

FIELD GEOLOGY

By MR. C. H. CLAPP.

Field geology is to the geologist what surveying is to the civil engineer; indeed courses in the subject are ordinarily designated as geological surveying. The geological surveyor goes into the field, notes the different types of rock exposed, maps the distribution of each kind, and determines as far as possible their relation to each other, and to the whole geological province. The last of these duties is the most difficult, the most illusive, yet the most important. It should never be lost sight of during the field mapping any more than the unity of a composition, or a picture should be lost sight of during the working out of the details. In the determination of rock structure and rock relationship, the geologist becomes more than a mere observer but an interpreter of observed facts. In large part, however, field geology consists in observing and recording the facts of geology.

These facts are recorded in the field, usually on topographic maps which have been previously prepared for the geologist's use. Each rock formation, which is shown on the geological map, is given a particular color or pattern, so that by reference to an explanatory legend, one may readily acquire a knowledge of the various types of rocks occurring in the region represented by the map. The distribution of each formation is shown on the map by the extent of each color, or pattern. The locating or "tracing" of the boundaries or "contacts" of each formation therefore becomes of paramount importance. It is also along the contacts that the relationship between the contiguous formations are usually best exposed. The relation may often be shown directly on the map in some conventional manner, or more commonly is indicated by "structure sections." These sections give the altitude of each formation, and their relation to each other, as these features would appear if a deep slice was made in the earth's crust, along the line of the section, and the cutting exposed to view. Such sections are, in part, theoretical, but if constructed with care, have a very high degree of probability. Thus by means of maps and sections it is possible to represent the various rock formations as they actually exist in nature.

Geological maps are prepared and published by the various state and national geological surveys. The published maps may be obtained by any one interested in a particular district, free, or at a nominal cost. Geological surveys are also often carried out by private individuals and corporations, notably railroads and mining companies. Such surveys are usually of a detailed and special nature, but are based on the larger, more general surveys carried on by the government.

Geological data which is made available through maps and reports, becomes of direct practical importance when applied to certain business enterprises, not only those dealing primarily with the exploitation of the mineral resources of a region, but with all that have to do with underground work of any kind. It is necessary to know, for instance, in the construction of a tunnel, what kind of rock will be encountered in the center of a hill or mountain range, as well as on the flanks. The geological structure must also be considered. In the development of the mineral resources of a country, geology is of the foremost importance, especially in the location of mineral deposits. Certain deposits such as coal, occur as beds in well defined formations, the underground structure of which may be foretold with a great deal of accuracy from an examination of surace features. Some formations at certain critical places are favorable for the location of metallic ores, and the recognition of these places is one of the chief duties of the field geologist working in undeveloped regions. Large areas of rock may sometimes, almost assuredly, be determined as non-mineral bearing, and the expense of a large amount of worthless prospecting may be thereby saved. In the working of deposits of metallic ores, it is necessary to arrive at some conclusions as to the origin of the ores in order to gain the assurance which is necessary to sink shafts and drive tunnels for long distances. The various theories of the genesis of different types of ore deposits are intimately related to the theoretical geological history of the particular region in which the ores are found.

All geological theories and speculation must be based primarily on field work. Those hypotheses which do not accord with the observed field facts must of course be discarded. Discussion properly follows the accumulation of data. Field facts were overlooked by the earliest geologists in favor of certain preconceived ideas; they preferred to speculate rather than to observe. Interprtation is a necessary corollary of observation; the bare facts must be moulded by imaginative thinking into an understandable sequence and form. Field geology is, however, the basis, the foundation not only of speculation, but even of the theories and hypotheses which today are ordinarily accepted as the truth.

ECONOMIC GEOLOGY.

(Continued from column 1.)

ferent kinds of rock. He should, therefore, like the mining engineer, have some training in structural geology as well as petrology.

Water-supply problems may require for proper solution application of the several branches of geology, especially of physiography and in some cases of paleontology, as is illustrated by the investigations of Prof. Crosby for the New York Water-Supply Board. That great general question, the conservation of natural resources, also depends upon the several branches of geology for its answer.

Proof of the present appreciation of economic geology lies in the rapid growth of the science in late years. The United States Geological Survey, maintained largely for its aid in the development of the country's mineral resources, has done much towards placing economic geology upon its present basis. The results of the Survey' work have induced many states in all parts of the union to organize state surveys. Several private corporations, especially those operating mines and railroads in the west, permanently employ geologists, while a few geologists are successfully established in independent consulting work.

Economic Geology, utilizing as it does all other branches of geology for the common good, is necessarily the most important and advanced branch of the science. It is with this fact in view that the geologic courses at the Institute are given.

CONCENTRATES.

It is interesting to note that the mining course of the recently established Nova Scotia Technical College, as set forth in their catalog, seems to be patterned on the mining course given at Tech. Prof. Richard's "Mining Notes," former Prof. Lodge's "Notes on Assaying," as well as other Institute books are used in the Nova Scotia Tech.

Professor Sexton, the Director of Technical Education for the Province of Nova Scotia, graduated from the Institute Mining Course in 1901.

That the instruction given in geology at Tech is second to none is shown by the number of men that the Geological Survey of Canada sends to the Institute for graduate work. Last year, five men from Ottawa were here doing research work, or candidates for advanced degrees, and again this year, five men connected with the Canadian Survey are at the Institute.